National Aeronautics and Space Administration

Unmanned Aerial Systems Traffic Management (UTM)

SAFELY ENABLING UAS OPERATIONS IN LOW-ALTITUDE AIRSPACE

NEXTGEN

NASA

http://www.utm.arc.nasa.gov

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Requirements are Different

http://www.kcet.org/updaily/socal_focus/history/la-as-subject/7th-and-broadway.html
1920, Photo Collection, Los Angeles Public Library

Low-Altitude Unmanned Aerial System Operations

Goal: Ensure safe and efficient operations

NASA's UTM Research Goals and Characteristics

- Conduct research, development and testing to identify airspace operations requirements to enable large-scale visual and beyond visual line of sight UAS operations in the low-altitude airspace
  - Collaborate with FAA, DOD, DOI, and DHS through Research Transition Team
  - Collaborate and leverage industry capabilities and insights
  - Partner with FAA test sites for testing
  - Partner with FAA COE for key research needs
- Use build-a-little-test-a-little strategy – remote areas to urban areas
  - Low density: No traffic management required but understanding of airspace constraints
  - Cooperative traffic management – Understanding of airspace constraints and other operations
  - Manned and unmanned traffic management – Scalable and heterogeneous operations
- UTM construct consistent with FAA's risk-based strategy
- UTM research platform is used for simulations and tests
- UTM offers path towards scalability

Balancing Multiple Needs

National and Regional Security

Protecting key assets

Safe Airspace Integration

Mantra 1: Flexibility where possible and structure where needed

Mantra 2: Risk based- Geographical needs, application, and performance-based airspace operations

Scalable Operations for Economic Growth

Ever-increasing applications of UAS: Commercial, Agricultural, and Personal

Principles and Services for Safe Integration

- Principles
  - Authenticated users and UAS are allowed to operate in the airspace
  - UAS stay clear of each other
  - UAS and manned aircraft stay clear of each other
  - UAS operator has complete awareness of airspace and other constraints and stay clear of them
  - Public safety UAS have priority over other UAS

- Key UAS related services
  - Authentication
  - Airspace configuration and static and dynamic geo-fence definitions
  - Weather and wind prediction and sensing
  - Conflict avoidance (e.g., airspace notification, V2V)
  - Demand/capacity management
  - Large-scale contingency management – GPS outage, cell outage, etc.

- Research prototype is cloud-based

- UTM research identifies roles and responsibilities of operator, air navigation service provider, and UAS support service providers

Defining UAS Operator and ANSP/UTM Roles

UAS Operator

- Work with Original equipment manufacturer
- Communication, Navigation, and Surveillance (CNS)
- Register
- Train/qualify to operate
- Avoid other aircraft, terrain and obstacles
- Respect airspace constraints
- Avoid incompatible weather

Through

- Performance-based regulation where practical
- Limited categories of operator types, matched to regulations

Third-party entities may provide support services but are not separately categorized or regulated.

Air Navigation Service Provider (ANSP)

→ ***UAS Traffic Management (UTM)***

- Define airspace constraints
- Foster collaboration among UAS operators to deconflict their operations
- Where demand warrants, provide air traffic control

Through

- Near real-time airspace control
- Where it is needed, air traffic control integrated with manned aircraft traffic control

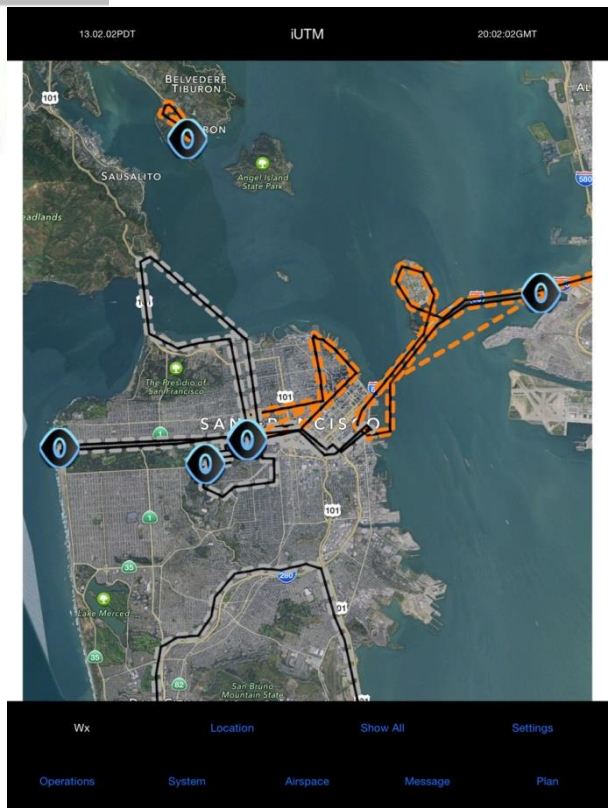
UAS Operator/UTM Functions

UTM: AIRSPACE MANAGEMENT

- Notifications accessible to UAS operators and public
- Static (like TFR) and dynamic (like security or public health scenario)

UAS OPERATOR

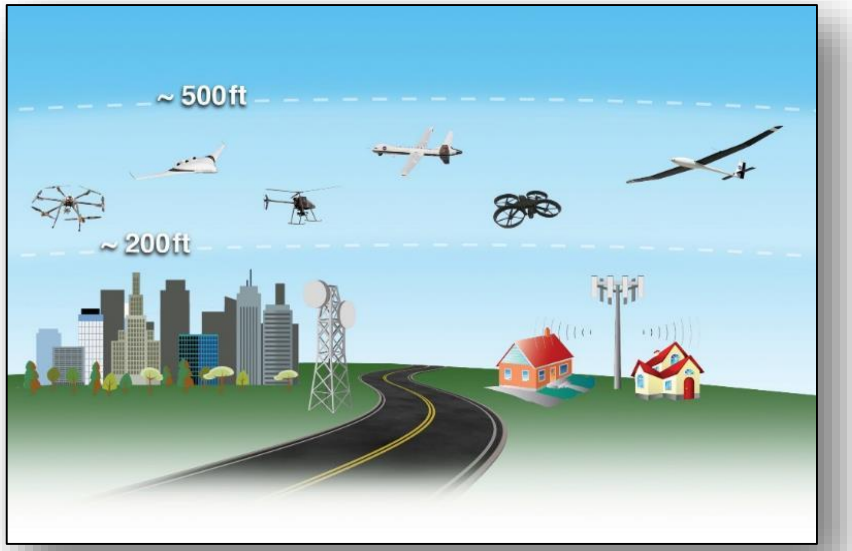
- Broadcast identity (and possibly intent)
- Operations accessible by all
- No anonymous flying



UAS Operator/UTM Functions

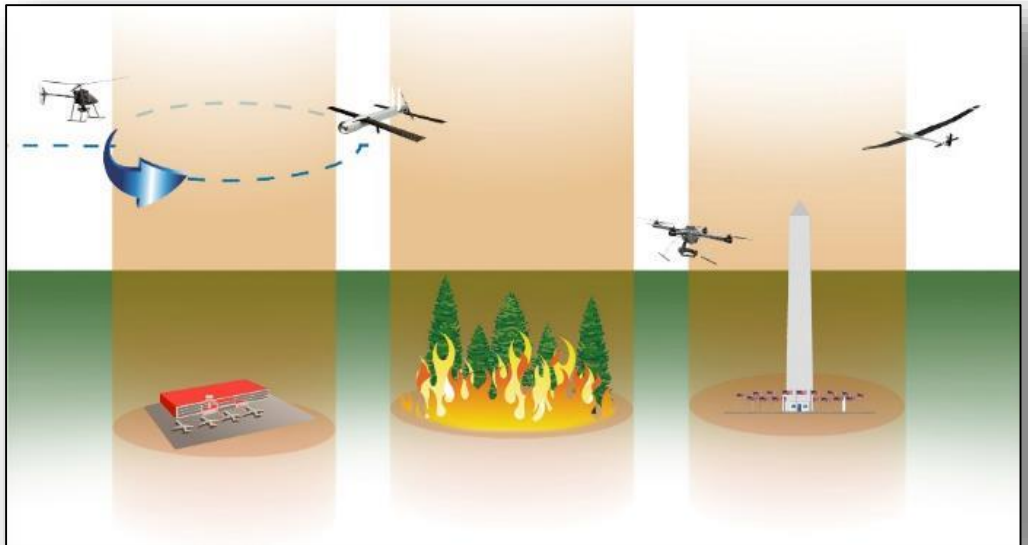
UTM: Example Airspace Management

- Consider other traffic and underlying environment
- Can be keep-out or keep-in requirement
- May be static or dynamic (near-real time)



UAS Operator:

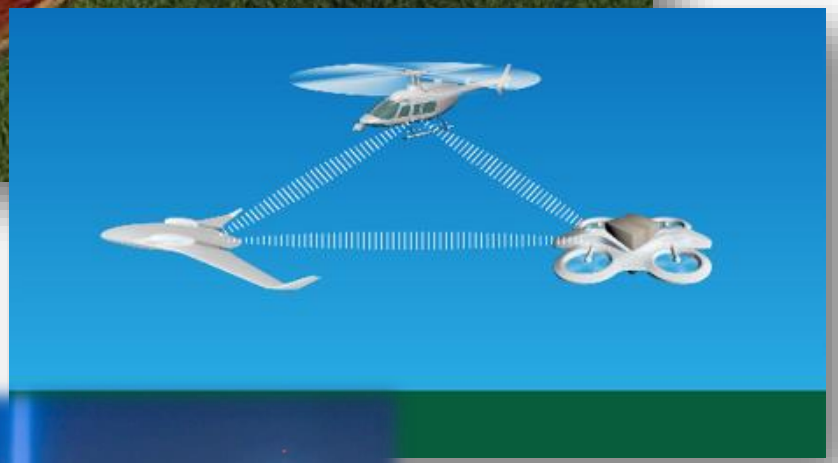
- Operator can comply through geofences or operational control



UAS Operator/UTM Functions

UAS Operator: Traffic Avoidance

- Detect Sense And Avoid (DSAA) to manned aircraft predicated on right of way
- Status and intent exchange in accordance with standards
- Collaborative decision making
- Contingency planning and response (system outages, unreported weather, etc.)



UTM: Enable Collaborative Exchange

- Standards for publish and access
- If needed, provision of data repository

UTM Functions

Route Structure

- Only where needed for safety or efficiency of flight
- Procedural rules-of-road (corridors, altitudes, etc).

Air Traffic Control

- Integrated with manned air traffic control, where positive UAS control is required for safety or efficiency of flight
- Static or dynamic application (e.g., ability to respond in crisis situation where sustained mixed operations are required)

Flow Control

- Only where needed for safety or efficiency of flight
- Manage access into areas of operation, not particular operation

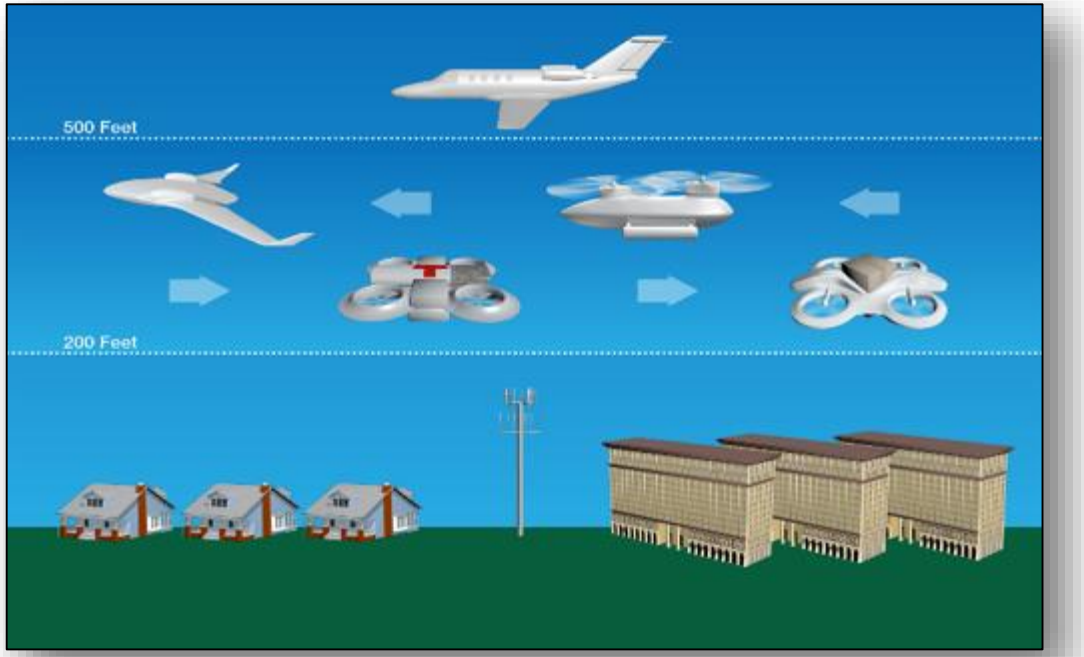
Mantra 1:
Flexibility where possible and structure where needed

Mantra 2:
Risk based- Geographical needs, application, and performance-based airspace operations

Supporting Functions

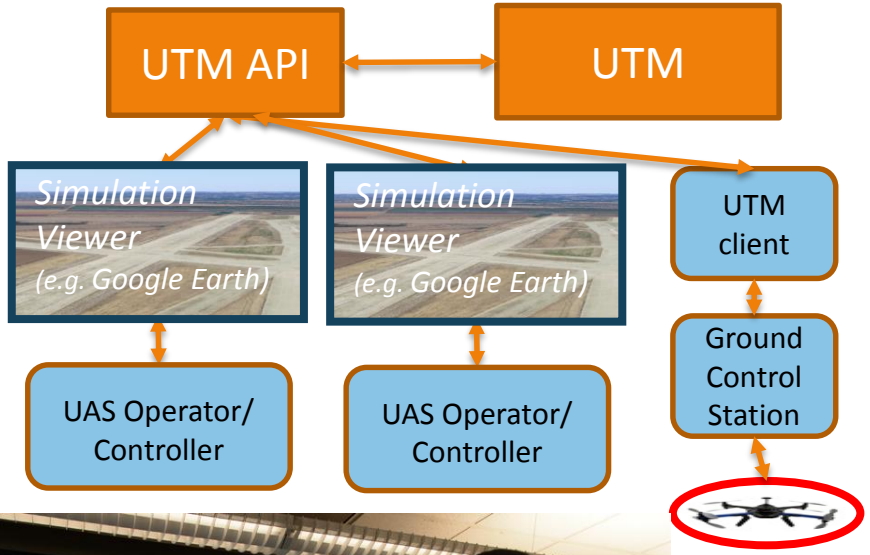
WIND & WEATHER INTEGRATION

- Operator responsibility, may be provided by third party
- Actual and predicted winds/weather
- No unique approval required



NASA UTM Simulation Capabilities

- Validation and Verification of UTM research prototype functions
- Develop, demonstrate, and evaluate advanced UTM services and operations
- Develop tools and procedures to manage UTM ops
- Accelerate and increase value of field tests and provide live virtual constructive (LVC) environments
- Simulate complex operations that cannot be done in the field (e.g. urban ops, 911 type scenarios)



UTM Research Technical Capability Level

Each capability is targeted to type of application, geographical area and uses risk-based approach

Capability 1 (August 2015)

- Reservation of airspace volume
- Over unpopulated land or water
- Minimal general aviation traffic in area
- Contingencies handled by UAS pilot
- Enable agriculture, firefighting, infrastructure monitoring

Capability 2 (October 2016)

- Beyond visual line-of-sight
- Tracking and low density operations
- Sparsely populated areas
- Procedures and “rules-of-the road”
- Longer range applications

Capability 3 (January 2018)

- Beyond visual line of sight
- Over moderately populated land
- Some interaction with manned aircraft
- Tracking, V2V, V2UTM and internet connected
- Public safety, limited package delivery

Capability 4 (March 2019)

- Beyond visual line of sight
- Urban environments, higher density
- Autonomous V2V, internet connected
- Large-scale contingencies mitigation
- News gathering, deliveries, personal use

Working Groups

- Collaborations in place with over 200 partners: industry, academia, and government are all represented
- Leveraging this by frequently meeting, obtaining solid stakeholder buy-in early and often on concepts
- Establishing semi-formal working groups to tackle specific issues, open to all of our collaborators to participate

Current Working Groups

Flight Planning

Ease use of the UTM System by developing services to bridge operators to UTM during flight planning. Additional services such as terrain checking, fleet optimization are possibilities

Conformance Monitoring

Ensure operations are staying where they said they would stay. Potential predictive capabilities to catch non-conformance as soon as possible.

Separation Assurance

Help monitor and alert for potential conflicts. Offer potential solutions to conflicts before vehicle to vehicle solutions are required.

Public Safety

Allow access to the airspace for public safety functions: police, fire, medical, national security, etc. Develop standards for prioritization of access.

MultiUTM

Develop concepts for enabling multiple UTM instances to communicate. Potentially allow for several different UTM Service Suppliers.

National Safe UAS Integration Campaign

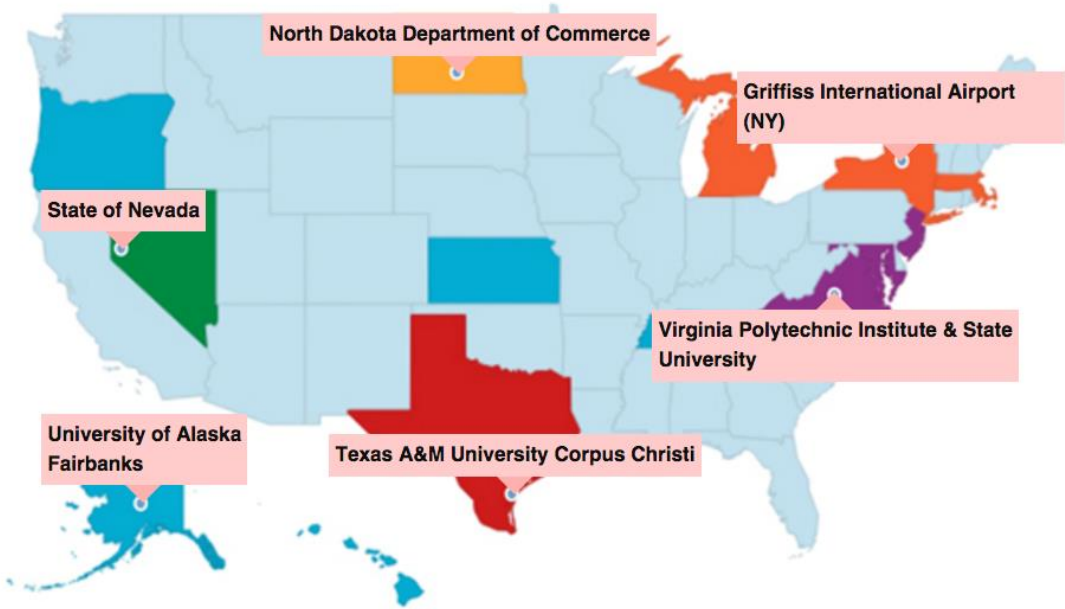
What: Demonstrated management of geographically diverse operations, 4 vehicles from each site flown simultaneously under UTM

Where: All 6 FAA UAS Test Sites

Who: NASA, Test Sites, support contractors

When: 19 April 2015

24 live vehicles, over 100 live plus simulated flights under UTM in one hour



Obtain detailed feedback from the FAA Test Sites on the UTM concepts, technologies and operations

Learn what requirements might be needed for management of geographically diverse operations

NuSTAR: Performance Benchmarking for sUAS

- Performance benchmarking: responsible, credible, collaborative
- National UAS Standardized Testing and Rating (NuSTAR)
- Parallel: Underwriter's Laboratory, Consumer Reports, JD Powers, Which?
- Credible test bed and scenarios
  - Drop tests
  - Urban, rural, atmospheric conditions (e.g., fog, smog, rain)
  - Simulated pets
  - Failure modes
  - Sub-system level performance: engine/propulsion, networking, battery, sensor systems, software systems
  - Cyber-security, GPS denied conditions, etc.
- Support UAS manufacturers, consumers, insurance companies, and public at large through objective assessments for self-certification to meet FAA requirements
- Forensics analysis: Re-creation of incidents and accidents

Summary and Next Steps

- NASA works closely with many industry, academia, and government partners
- NASA and FAA have established Research Transition Team (RTT) to collaborate on UTM research – includes DOD, DHS, DOI
- NASA has over 200 collaborators and various work groups
- Test four technical capability levels
- Initial technical capability level 1 was initially tested in August 2015
- Capability 1 was further successfully tested simultaneously with all six FAA test sites
- Capability level 2 will be tested in October (target: Beyond Visual Line of Sight)
- Continue collaboration with all